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**Preliminary Screening Level
Ecological Risk Assessment**

40247999



SUPERFUND RECORDS

for

**Fish and Wildlife Habitats around the
Doe Run Company Lead Smelter,
Herculaneum, Missouri**

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Introduction

Over the past several years, U.S. Fish and Wildlife Service (USFWS) personnel have monitored habitat quality along the Mississippi River as part of their trustee responsibilities. The results of these monitoring activities indicated that very elevated concentrations of heavy metal pollutants were observed in the Middle Mississippi River and in Joachim Creek around the confluence of these two waterways (south of the City of St. Louis, Jefferson County, Missouri).

Recently, personnel from other Federal and State research, enforcement and response agencies have started to discuss and cooperatively investigate the ~~contaminant problems for this site.~~

This report was prepared to organize and interpret the existing environmental data for this part of the Mississippi River. The report follows steps one and two of the *Eight - Step Process for ecological risk assessment* developed by the U.S. Environmental Protection Agency (USEPA 1977). The first two steps of an ecological risk assessment are also known as the screening level because the purpose is to compare the site chemistry data with literature based toxicity values to screen for contaminants that may cause risks. The procedures for the first two steps are outlined below are developed in the following pages of this report.

Step One:

- Develop preliminary site history and site ecology information
- Formulate potential contaminant problems (Problem Formulation)

Step Two:

- Compile relevant toxicity reference data from literature sources (Toxicity Evaluation)
- Organize site environmental chemistry data (Exposure Estimate)
- Compare site chemistry data to toxicity reference data (Risk Calculation)
- Uncertainty Analysis
- Initial conclusions and decision point to continue the assessment

A complete ecological risk assessment can accompany the human health risk assessment for a site as part of a remedial investigation. The risk information is used during the feasibility study phase to engineer remedies that are protective of human health and the environment. A properly designed ecological risk assessment will provide site specific contaminant affects levels which allows ~~natural resource trustees to estimate the ecological risks associated with each of the remediation alternatives and to restore habitats to baseline conditions.~~

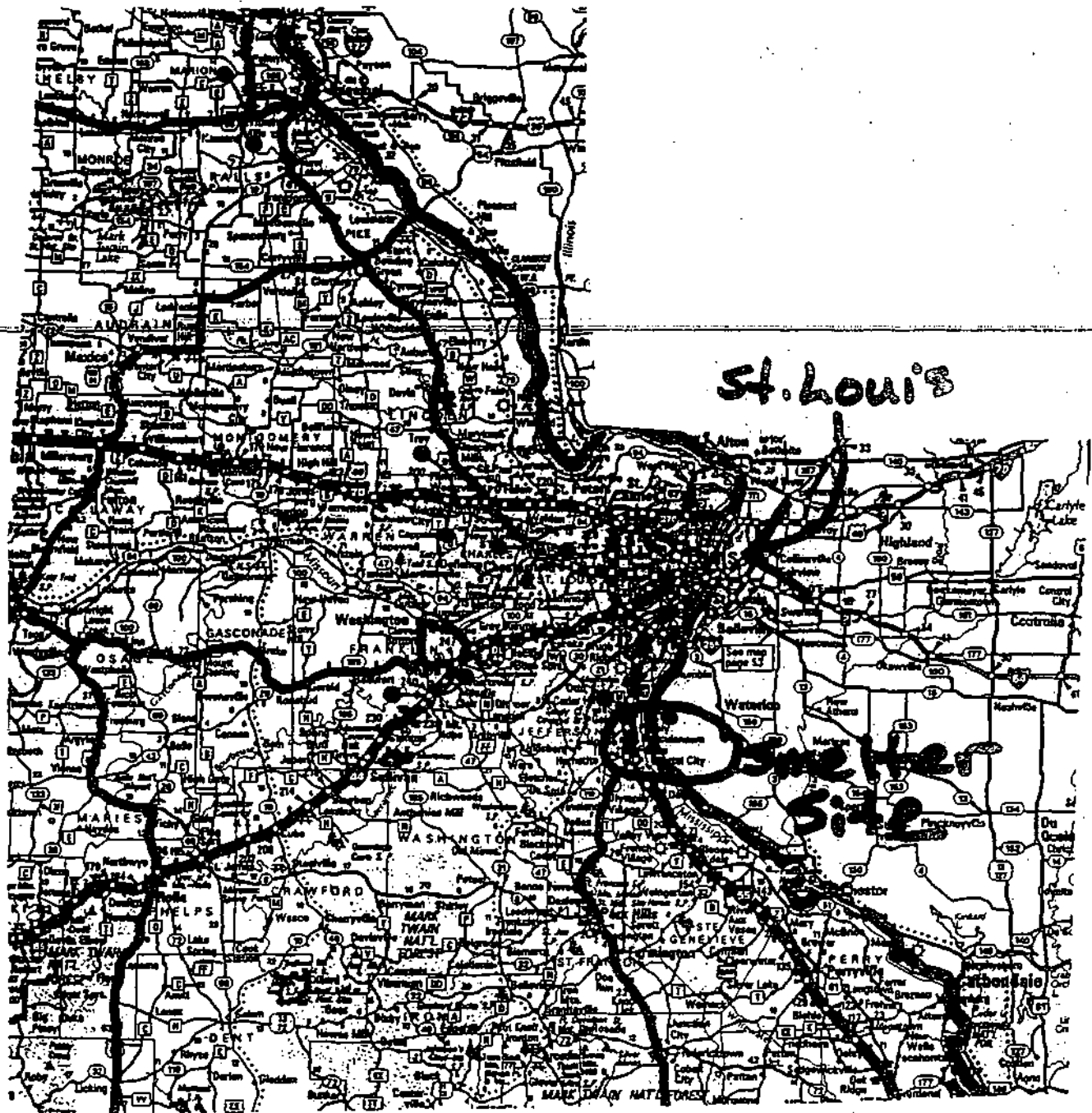


Figure 1. Location of the Doe Run lead smelter, Herculaneum, Jefferson County, Missouri.

Site History

The site is adjacent to the small city of Herculaneum which is about 30 miles south of the Saint Louis metropolitan area. Between the town of Herculaneum, the Mississippi River and Joachim Creek is a lead smelter that has been in operation since the mid 1800's and is now operated by the Doe Run Company. The Doe Run Company mines and refines lead ore. The Company's Herculaneum facility contains a primary stage smelter.

The smelter facility has wastewater discharges under a Clean Water Act permit into the Mississippi River. There appears to have been incidents where this discharge has exceeded established permit limits for short periods. The smelter facility also has stormwater discharges into Joachim Creek which are not permitted at this time. The Company is in the process of amending the existing wastewater discharge permits with the state regulatory office to include stormwater discharges. The City of Herculaneum also has a discharge structure into Joachim Creek for its sewage treatment plant which appears to contain heavy metal contaminants that are not expressed in the permit limitations at this time.

The smelter has several air emission points under a Clean Air Act permit. Site specific studies are on-going to develop a State Implementation Plan (SIP) for this area because of air quality non-attainment problems.

Large volumes (estimated between 25 and 40 surface acres) of solid waste material generated by the smelter facility are stored in the floodplain of Joachim Creek near the mouth to the Mississippi River. There does not appear to be any protective barriers to stop erosion (especially during flood events) of the solid waste into nearby rivers. Refer to the photographic record in Appendix B.

Site Ecology

The area around the confluence of the Middle Mississippi River and Joachim Creek contains open water, seasonal wetlands and bottomland hardwood forest tracts. The river and creek bottomlands are flooded a few to several times per year related to snow melt and seasonal storms. These habitats support a variety of fish and wildlife including species under the trusteeship of the USFWS. Trust species include migratory birds and endangered species. A wide variety of migratory birds use these habitats during the breeding season and during migration times. There are migratory birds that use the site throughout much of the year such as red-tailed hawk, belted kingfisher and great blue herons. The Federally listed threatened bald eagle was observed using the site. The site contains suitable habitat and is within the range of the Federally listed endangered fish species the pallid sturgeon.

Step One: Problem Formulation

Potential Contaminants Problems

Floodplain soil, river sediments and surface waters are polluted with several heavy metal contaminants that include arsenic, cadmium, copper, lead, nickel and zinc (Appendix A). These contaminants may be at concentrations that are toxic to desirable plants, invertebrates and fish that come in direct contact with the polluted media. The solid waste material in the floodplain caused mortality to larval fish in a recently conducted standard toxicity test (Appendix A).

Contaminants in the various media may also transfer through the food chain and pose risks to animals. Moderately contaminated soil may produce earthworms and support plants that are not killed by direct exposure. The earthworms may accumulate the contaminants in their body and plants may accumulate contaminants in the leaves and fruit. Animals such as the shrew, robin and woodcock that eat the worms may be at risk. Herbivores such as the white-footed mouse and cottontail rabbit that eat the plants may be at risk. Fish from the river or creek may be contaminated and at risk from direct exposure to pollutants in the water or river sediments. Mink and fish-eating birds such as the kingfisher, great-blue heron and bald eagle that feed on these fish can be exposed to levels of contaminants that may affect their health. There may be health risks to predators such as the red-tailed hawk that eat the contaminated prey items (mice and rabbits). Highly contaminated dust and soil particles may also cover food items for wildlife and contribute to the risk. The availability of site soil, sediment and water contaminants to bioaccumulate in fish, mice and bird tissues is confirmed by chemistry tests completed by the authors (Appendix A).

Tentative Ecological Receptors

Receptors are grouped as aquatic or terrestrial and by the way the organism comes in contact with the contaminated media. Aquatic exposure pathways are grouped in an aquatic model and likewise for the terrestrial pathways. The aquatic model developed for this assessment includes the direct contact (water and sediment) pathway for common freshwater invertebrates that live in river or wetlands and the fish-to-great blue heron (*Ardea herodias*) food chain pathway. The terrestrial model developed for this assessment includes the direct contact (soil) pathway for common invertebrates and plants and the earthworm-to-American robin (*Turdus migratorius*) food chain pathway. The terrestrial model also includes the mouse-to-red tailed hawk (*Buteo jamaicensis*) food chain pathway. The estimate of risk for these receptors may be viewed as indicators of ecological health problems for the site that includes chemical toxicity for many different species that inhabit the area and the loss of important food resources for these species.

Toxicity Evaluation

Direct Toxicity

Modeling the direct toxicity of contaminated water, sediment, and soil is done by dividing the concentration of a contaminant found at the site by a toxicity reference value also known as an ecotoxicological benchmark for that contaminant. The benchmark is a concentration of the contaminant that has been shown to have little or no adverse affect on biota. Benchmarks used in the direct toxicity models are specific to the media (water, sediment or soil) and biota (plants or invertebrates). For the models the maximum contaminant concentration ~~for a particular media and pathway is divided by the lowest available benchmark~~ and the result is referred to as the hazard quotient (HQ). HQ less than one indicates likely no risk and an HQ equal to or greater than one indicates that there is the potential for risk.

There are several readily available databases that contain ecotoxicological benchmarks for aquatic life for water and aquatic sediments. These benchmarks were typically derived from data for a variety of freshwater organisms. We selected four databases for this assessment that include USEPA Region III risk screening levels, Oak Ridge National Laboratory screening numbers, USEPA Waste Site EcoTox numbers and the USEPA Ambient Water Quality Criteria. Typically the lowest available value is selected as a conservative approach.

There are fewer readily available databases that contain ecotoxicological benchmarks for soil dwelling invertebrates and plant processes. A couple of databases exist and include USEPA Region III risk screening levels and Oak Ridge National Laboratory screening numbers.

Indirect Toxicity

Modeling the food chain transfer toxicity for wildlife from ingesting contaminated food items becomes more complicated. A dose formula is constructed that includes several parameters. The dose formula parameters include receptor body weight, daily food and water ingestion rates and contaminant concentration in the food item which is based on the maximum concentration in a media and the bioaccumulation factor. The dose formula calculation is expressed as daily dose of the contaminant consumed by the receptor in milligrams/Kilogram-day/body weight. This number is then divided by a benchmark representing a daily dose that has little or no observed affect on the receptor. The resulting number is the HQ. The HQ may be set at one and the formula back calculated to get a ~~contaminants affects level in the food item or media.~~ Receptor benchmarks are available in various reference documents and in the scientific literature.

Step Two: Exposure Estimates and Risk Calculations

Exposure Estimates

The maximum contaminant concentrations for the various media were used as an estimate of exposure for the aquatic and terrestrial models to screen for contaminants of concern and contaminant pathways (Table 1). The maximum concentration is used versus the average or other data in the screening level phase as a conservative approach. Environmental chemistry data for the various media were available from the USFWS monitoring activities and 1998 USEPA field investigations.

Summary of Monitoring Data and Field Investigation Data

The below described data were generated by the USFWS except where noted otherwise (raw data in Appendix A).

Upland Soils: Four soil samples were collected in November 1997 at a city park and baseball diamond located west of the smelter facility air stacks. This direction may be toward versus down gradient of prevailing winds based on meteorological wind data for the City of St. Louis. The data range was 140 to 1000 milligrams lead per kilogram on a dry weight basis. An average background concentration for soil lead is about 20 milligrams per kilogram on a dry weight basis.

River Floodplain Soils: Six Joachim Creek floodplain substrate samples adjacent to the slag piles were collected in March 1998 during a joint USEPA and USFWS field investigation. The data range was 109 to 26,900 milligrams lead per kilogram on a dry weight basis.

River Channel Sediments: About sixteen aquatic sediment samples were collected between 1989 and 1995 at various locations downstream of the smelter facility in the main channels and channel borders for the Mississippi River and Joachim Creek. The data range was from normal up to 7,720 milligrams lead per kilogram on a dry weight basis. An average background lead concentration for aquatic sediments in Illinois streams is <60 milligrams of lead per kilogram on a dry weight basis.

Surface Water: About eleven surface water samples were collected between January and March 1998 from flowing floodplain ditches and floodwater pools in Joachim Creek floodplain. The samples were collected during a joint USEPA and USFWS field investigation. The data range was 10.4 to 13,300 micrograms lead per liter. The water hardness was about 380 milligrams per liter as Ca-carbonate.

Table 1. Maximum contaminant concentrations in the surface waters, aquatic sediments and soils (source of the data source is listed in parenthesis).

Contaminant	Surface Water micrograms/Liter (USFWS ¹)	Surface Water Micrograms/Liter (USEPA ²)	River Sediment milligrams/Liter, dry wgt. (USFWS)	Upland Soil milligrams/Liter dry wgt. (USFWS)	Floodplain Substrate milligrams/Liter dry wgt. (USEPA)
Arsenic		8.22	15.3		30.7
Cadmium	38	4270	33.0		115.0
Copper		11,800	1,060		1,700
Lead	40	13,300	7,720	1,000	26,900
Nickel	120	8,730	98.0		197.0
Zinc	600	310,000	29,400		99,900

¹ U.S. Fish and Wildlife Service

² U.S. Environmental Protection Agency

Biota Samples:

WHO LIMIT
FOC
EDIBLE
13.0.7

Fish: Nine whole fish samples were collected between 1992 and January 1998 from locations downstream of the smelter facility in the Mississippi River and Joachim Creek. The data range was 0.414 to 7.476 milligrams per kilogram on a wet weight basis. Fish collected from reference areas without an apparent significant source of lead contamination had a range of not being detected up to 0.297 milligrams lead per kilogram on a wet weight basis.

Mammals: Three whole white-footed mouse samples were collected in January 1998 at various locations along the shoreline of Joachim Creek adjacent to the smelter facility. The data range was 2.6 to 55.0 milligrams lead per kilograms on a wet weight basis.

Birds: The livers from twenty one "song birds" were collected in 1997 at various locations along the shoreline of Joachim Creek adjacent to the smelter facility. The data range was from not being detected up to 11.28 milligrams lead per kilogram on a wet weight basis. Five out of these 21 birds had liver lead values elevated above the threshold diagnostic of clinical lead poisoning (threshold = 6 milligrams per kilogram wet weight). Clinical poisoning is defined by impaired biological functions and can be life threatening. Eight of the remaining 16 birds had liver lead values elevated above the threshold diagnostic of subclinical lead poisoning (threshold = 2 milligrams per kilogram wet weight). Subclinical lead poisoning is defined by having physiological effects (Pain 1996).

NO
REFERENCE
AREAS

Note that several more fish, mice and frog samples are at the laboratory for analysis the time of this report.

Toxicity Testing: A sample of smelter slag materials collected in the floodplain of Joachim Creek was subjected to a standard laboratory 96 hour elutriate bioassay to evaluate the toxicity of this material to aquatic life. The test organism was the larval fathead minnow. At 24 hours 10 of the twenty organisms died. By 96 hours 18 of the 20 organisms died. The slag material and the toxicity test water were analyzed for heavy metal concentrations (Table 2).

Table 2. Contaminant concentrations (milligrams per Kilogram dry weight) in solid waste material (slag) stored in Joachim Creek floodplain.

Arsenic	Cadmium	Copper	Lead	Nickel	Zinc
28.0	32.0	3,200	23,000	140.0	96,000

Risk Calculations

The calculations for the risk models are presented in Microsoft Excel® spreadsheets (Tables 3 and 4). The HQ can be recalculated with any new chemistry data generated for this project. Several receptor parameters were not used in the dose formula that include fraction of diet as soil or water, area use factor, temporal use factor and seasonal use factor. Selected concentrations for the contaminants detected in the various media, ecotoxicological benchmark values, food chain transfer formula parameters and HQ values are listed in the spreadsheet tables.

Uncertainty Analysis

~~The concentrations of the environmental contaminants were based on limited number of samples~~ and test types and may represent an over or under estimate of exposure. A degree of uncertainty exists about the spatial distribution of the contaminants. The bioavailability of the contaminants for the direct contact pathways is uncertain. The transfer of contaminants from the media to organisms (bioaccumulation factor) is estimated or based on a limited number of samples. The ecological hazards are estimated and based on the conservative exposure factors of using maximum concentrations and lowest possible toxicity reference value.

The cumulative affects of toxicity from simultaneous exposure to a mixture of contaminants have not been addressed.

Conclusions

The purpose of the screening level assessment is to quickly and conservatively characterize risk. Given the high hazard quotients presented in Tables 3 and 4, ecological risks for several pathways are predicted at the fish and wildlife habitats around the Doe Run Company site in Herculaneum, Missouri (Table 5).

Table 5. Risk hazard quotients for lead contamination and preliminary affects levels for the screening level aquatic and terrestrial conceptual models, fish and wildlife habitats around the Doe Run lead smelter.

Exposure Pathway	Hazard Quotient	Screening Level Ecological Affects Concentration	
Surface water toxicity	5320	3.2	micrograms per Liter
Aquatic sediment toxicity	576	46.7	milligrams per Kilogram
Upland Soil toxicity - invertebrates	2690000	0.01	milligrams per Kilogram
Upland Soil toxicity - plants	13450	2	milligrams per Kilogram
Worm - robin	696		
Fish - heron	25989		
Mouse - hawk	9		

Table 3. Aquatic Model

Direct Toxicity of Contaminants of Interest

Water (Aquatic Life)		(Benchmark may be hardness, pH or temperature dependent)						
Contaminant of Interest	Maximum Concentration (ug/L)	Benchmark Tox 1	Benchmark Tox 2	Benchmark Tox 3	Benchmark Tox 4	Selected Benchmark	HQ	
Arsenic	8.22	874	914	190	48	48	0.17125	
Cadmium	4270	0.53	0.15	1	1.1	0.15	28466.667	
Copper	11800	6.5	0.23	21	12	0.23	51304.348	
Lead	13300	3.2	12.26	2.5	3.2	2.5	5320	
Nickel	8730	160	5	160	160	5	1746	
Zinc	310000	110	30	100	110	30	10333.333	
Sediment (Invertebrate)								
Contaminant of Interest	Maximum Concentration (mg/Kg)	Benchmark Tox 1	Benchmark Tox 2	Benchmark Tox 3	Benchmark Tox 4	Selected Benchmark	HQ	
Arsenic	30.7	8.2	12.1	8.2		8.2	3.7439024	
Cadmium	115	1.2	0.59	1.2		0.59	194.91525	
Copper	1700	34	28.01	34	41	34	50	
Lead	26900	46.7	34.9	47	55	46.7	576.01713	
Nickel	197	20.9	37.9	21		20.9	9.4258373	
Zinc	99900	150	159	150	110	110	908.18182	

Ecotoxicological Benchmark Values (Tox 1-4)

Tox 1: USEPA R3 BTAG screening level

Tox 2: ORNL 1996 & ORNL 1997

Tox 3: USEPA EcoTox

Tox 4: Sediment - Ingersoll, et al 1995

Tox 4: Water - USEPA NAWC/Chronic

Food Chain Model for the Great Blue Heron (*Ardea herodias*)

Contaminant of Interest	Sediment Maximum Concentration (mg/Kg)	Food Source BAF	DW to WW Conversion	Body Wgt (Kg)	Food Ingest Rate (Kg-d)	Normalized Food Rate	Sed. Ingest Rate	Water Intake Rate	Dose mg/Kg-d/b	Estimated NOAEL	HQ
Lead - Floodplain	26900	1	8035.03	2.39	0.18	0.4302			3456.6699	0.133	25989.9993

Table 4. Terrestrial Model

Direct Toxicity of Contaminants of Interest

Soil - Floodplain (plant)					
Contaminant of Interest	Maximum Concentration (mg/Kg)	Benchmark Tox 1	Benchmark Tox 2	Selected Benchmark	Plant HQ
Arsenic	30.7	328	10	10	3.07
Cadmium	115	2.5	4	2.5	46
Copper	1700	15	100	15	113.33333
Lead	26900	2	50	2	13450
Nickel	197	2	30	2	98.5
Zinc	99900	10	50	10	9990

Ecotoxicological Benchmark Values (Tox 1-4)

Tox 1: USEPA R3 BTAG screening level for flora/fauna
Tox 2: ORNL 1997

Soil - Floodplain (invertebrate)					
Contaminant of Interest	Maximum Concentration (mg/Kg)	Benchmark Tox 1	Benchmark Tox 2	Selected Benchmark	Invert. HQ
Arsenic	30.7		60	60	0.5116667
Cadmium	115		20	20	5.75
Copper	1700		50	50	34
Lead	26900	0.01	500	0.01	2690000
Nickel	197		200	200	0.985
Zinc	99900		200	200	499.5

Soil - Upland (Plant & Invertebrate)					
Contaminant	Maximum Concentration (mg/Kg)	Benchmark	Benchmark	Selected	Invert.
Lead - Invertebrate	1000	0.01	500	0.01	100000
Lead - Plant	1000	2	500	2	500

Food Chain Model for American Robin (*Turdus migratorius*)

Contaminant of Interest	Maximum Concentration (mg/Kg)	Food Source BAF	DW to WW Conversion	Body Wgt (Kg)	Food Ingest Rate (Kg-d)	Normalized Food Rate	Soil Ingest Rate	Water Intake Rate	Dose mg/Kg-d/bw	Estimated NOAEL	HQ
Lead - Floodplain	26900	1.24	9963.4372	0.0773	0.1175	0.0090828			90.4954092	0.13	696.118533
Lead - Upland	1000	1.24	370.388	0.0773	0.1175	0.0090828			11.26261	0.13	86.6354615

Food Chain Model for Red tailed Hawk (*Buteo jamaicensis*)

Contaminant of Interest	Maximum Concentration (mg/Kg)	Food Source BAF	Food mg/Kg	Body Wgt (Kg)	Food Ingest Rate (Kg-d)	Normalized Food Rate	Soil Ingest Rate	Water Intake Rate	Dose mg/Kg-d/bw	Estimated NOAEL	HQ
Lead - Mice			55	1.3	0.11	0.143			7.865	0.87	9.04022989

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Appendix A

Chemistry Data Summary Tables and Data Sheets

Chemistry Data Summary Tables and Data Sheets

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A - Aquatic Sediments Data Summary Table, 1989

B - Fish Data Summary Table, 1992

C - Aquatic Sediments Data Summary Table, 1995

D - Bird Data Summary Table

E - Fish Data Sheets, 1998

F - Mouse Data Sheets, 1998

G - Surface Water Data Sheets, Jan 1998

H - Slag Material Data Sheet, Jan 1998

I - Slag Material Toxicity Test Results, 1998

J - Soil Data Sheets, 1997

K - USEPA Surface Water Data Memo, Mar 1998

In 1989 the USFWS surveyed aquatic sediments along several points of the Mississippi River as part of a Mississippi River wide study. The sediment chemistry data from near the DOE RUN COMPANY and down river documented significantly high concentrations of heavy metals. These metals included arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn). Extremely high concentrations of lead, copper and zinc were detected. During drought years, the eroded flood-plain sediments and waste materials tend to accumulate in river systems near their source because of low water flow. 1989 was in the middle of a series of dry or drought years.

SAMPLE & LOCATION	AS	CD	CR	CU	NI	PB	ZN
All numbers are in parts per million dry weight (ppm)							
1. Meramac River - Mile 160.0 R	4.9	0.7	20.0	18.0	22.0	37.0	101.0
2. Doe Run - Mile 152.0 R	15.3	33.0	25.0	1060.	98.0	7720.	29400
3. Osbourne - Mile 146.5 L	5.2	32.0	25.0	1030.	92.0	7590.	23300
4. LaRouche - Mile 145.0 R	4.3	40.2	27.0	13.0	13.0	23.0	83.6
National Background Averages of Heavy Metals	8.0	0.5	53.0	25.0	20.0	20.0	54.0 0
Source: U.S. Geological Survey, 1971 & Illinois EPA 1984							
Numbers in bold reflect numbers higher than average							

B

In 1992 the USFWS collected sixteen fish by means of electro-shocking from the Mississippi River. Eight fish were collected upstream and eight fish were collected downstream of the DOE RUN COMPANY. Twelve of these fish were sampled for concentrations of heavy metals. The heavy metal test results in the fish revealed a significantly higher concentration of lead and cadmium in the fish collected below the DOE RUN COMPANY than the fish collected above the facility. ~~The other metals are generally higher than the national average of heavy metal concentrations found in fish.~~ The ppm's in wet weight of the various heavy metals found in the fish is shown in the following chart.

1992 MISSISSIPPI RIVER FISH SURVEY FOR HEAVY METALS								
SAMPLE	SPECIES	AS	CD	CR	CU	NI	PB	ZN
* = downstream	All numbers are in parts per million - wet weight / — = Not Detected							
7-1-F-2*	carpsucker	—	.045	2.55	.824	3.737	3.920	14.18
7-1-F-3*	carpsucker	.227	.042	2.13	.801	4.125	.414	17.57
7-1-F-4*	carp	.251	.691	1.80	1.195	—	1.291	60.94
7-1-F-5*	carp	.147	.227	—	1.102	—	7.476	57.65
7-1-F-6*	channel catfish	—	.162	—	.323	—	1.360	18.64
7-1-F-8*	channel catfish	—	.075	1.67	.441	—	1.080	16.68
# = upstream								
7-1-F-11#	channel catfish	.157	.031	—	.340	—	.206	15.10
7-1-F-12#	carp	.131	.102	—	1.021	—	—	59.62
7-1-F-13#	carp	—	—	—	.867	—	—	39.43
7-1-F-14#	carpsucker	.166	—	1.42	.764	2.405	.297	13.12
7-1-F-15#	carpsucker	—	—	2.50	.701	3.276	.246	13.20
7-1-F-16#	channel catfish	.139	—	—	.414	—	.142	15.42
National averages of heavy metals		0.14	0.03	?	0.65	?	0.11	21.7
Source: USFWS, 1990, National Contaminant Biomonitoring Program in U. S. Freshwater fish								
Numbers in bold reflect numbers higher than National average								

C

1995 AQUATIC SEDIMENT SURVEY:

1995 MISSISSIPPI RIVER AQUATIC SEDIMENT SURVEY FOR HEAVY METALS								
SAMPLE	LOCATION	AS	CD	CR	CU	NI	PB	ZN
All numbers are in parts per million / — = Not Detected								
HC-95-1	Upriyer	7.7	—	19.0	17.0	19.0	59.0	84.0
HC-95-2	Control	—	—	0.03	—	—	—	0.09
HC-95-3	Discharge	5.4	—	12.0	16.0	14.0	150.0	73.0
HC-95-4	Creek	7.0	—	21.0	16.0	23.0	19.0	69.0
HC-95-4A	Creek	6.8	—	25.0	16.0	22.0	19.0	69.0
Averages of heavy metals		8.0	0.5	53.0	25.0	20.0	20.0	54.0

Source: U.S. Geological Survey, 1971 & Illinois EPA 1984

Numbers in bold reflect numbers higher than average

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1997 MIGRATORY BIRD SURVEY:

In 1997 the USFWS collected twenty-one migratory birds from areas along Joachim Creek, near the DOE RUN COMPANY in Jefferson Co., MO. The livers and tissues from the twenty migratory birds were tested for heavy metal concentrations. The results of the bird tissue analysis indicated that five out of the twenty sampled birds had liver lead concentrations that are diagnostic of clinical lead intoxication. Clinical intoxication is defined as biological functions are impaired, external signs are present and may be life threatening if there has been chronic or acute toxic level exposure. Eight of the birds had subclinical intoxication. Subclinical intoxication is defined as having physiological effects present but no biological impairment. The results of the heavy metals tests are shown on the following chart.

1997 JOACHIM CREEK BIRD SURVEY FOR HEAVY METALS								
SAMPLE	SPECIES	AS	CD	CR	CU	NI	PB	ZN
All numbers are in parts per million - wet weight / — = Not Detected.								
97HERCO1	common grackle	—	8.09	—	4.32	—	10.37	29.06
97HERCO2	common grackle	—	1.45	—	3.36	—	10.94	23.92
97HERCO3	common grackle	—	1.05	—	3.40	—	11.23	19.73
97HERCO4	cedar waxwing	—	0.25	—	4.17	—	1.02	22.37
97HERCO5	cedar waxwing	—	0.05	—	4.36	—	—	18.76
97HERCO6	cedar waxwing	—	0.12	—	4.33	—	2.98	22.10
97HERCO7	cedar waxwing	—	0.13	—	6.19	—	—	23.23
97HERCO8	cedar waxwing	—	0.29	—	4.36	—	6.93	22.32
97HERCO9	red-winged bb	—	0.21	—	4.62	—	2.44	17.83
97HERCO10	brown-headed bb	—	0.16	—	5.51	—	2.25	19.09
97HERCO11	tree swallow	—	0.76	.645	3.68	—	5.05	17.81
97HERCO12	barn swallow	—	1.13	—	4.12	—	4.76	15.99
97HERCO13	barn swallow	—	0.49	—	4.40	—	0.57	15.60
97HERCO15	barn swallow	—	0.51	—	3.84	—	1.95	16.37
97HERCO16	barn swallow	—	0.99	—	4.39	—	1.42	16.13

Why not a
comparison?
2002

1997 JOACHIM CREEK BIRD SURVEY FOR HEAVY METALS								
SAMPLE	SPECIES	AS	CD	CR	CU	NI	PB	ZN
97HERCO17	common grackle	—	1.41	—	2.99	—	8.40	14.66
97HERCO18	common grackle	—	0.34	—	3.09	—	1.31	14.60
97HERCO19	common grackle	—	0.37	—	3.50	—	2.06	15.95
97HERCO20	common grackle	—	1.53	—	5.14	—	3.43	23.27
97HERCO21	tree swallow	—	0.37	—	3.20	—	2.41	13.12
Background Levels: Columbiformes							<2.0	
Source: Environmental Contaminants in Wildlife, 1996								
The detectable rate varied by size of the tissue sampled								
Numbers in bold reflect numbers higher than background levels								

Source: Environmental Contaminants in Wildlife, 1996

The detectable rate varied by size of the tissue sampled

Numbers in bold reflect numbers higher than background levels



Hygienic Laboratory



The University of Iowa

Date of report: 04-07-1998

|||||
MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9852594
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site below dam
Collection Town Joachim Creek
Description whole fish
Reference 98-HC-F-12A
Collector
Phone (309)-793-5800
PWS Id & Type
Purchase Order 14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	< 1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	< 0.1 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	< 1.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	0.43 mg/kg as rec'd.	EPA 7421	SB/VD	04-01-1998
Total Nickel	< 5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	21 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.

APR - 8 1998



The University of Iowa

Sample Number	9852595
Date Received	03-03-1998
Project	
Date Collected	01-28-1998
Collection Site	below dam
Collection Town	Joachim Creek
Description	whole fish
Reference	98-HC-F-12B
Collector	
Phone	(309) 793-5800
PWS Id & Type	
Purchase Order	14480003941096

MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	< 1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	< 0.1 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	< 1.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	0.52 mg/kg as rec'd.	EPA 7421	SB/VD	04-01-1998
Total Nickel	< 5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	22 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

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Hygienic Laboratory

The University of Iowa

Date of report: 04-07-1998

|||||||
MIKE COFFEY

US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469 48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9852596
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site below dam
Collection Town Joachim Creek
Description whole fish
Reference HC-98-F-15
Collector
Phone (309) 793-5800
PWS Id & Type
Purchase Order 14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	<1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	1.1 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	<1.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	1.1 mg/kg as rec'd.	EPA 7421	SB/VD	04-01-1998
Total Nickel	<5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	79 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

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Hygienic Laboratory



The University of Iowa

Date of report: 04-07-1998

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MIKE COFFEY

US FISH & WILDLIFE SERVICE (I)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9852597
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site upper bend meander
Collection Town Joachim Creek
Description whole mouse
Reference 98-HC-M-1
Collector
Phone (309)-793-5800
PWS Id & Type
Purchase Order 14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	< 1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	0.4 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	4.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	55 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Nickel	< 5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	35 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

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Hygienic Laboratory

The University of Iowa

Date of report: 04-07-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (I)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9852598
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site upper bend meander
Collection Town Joachim Creek
Description whole mouse
Reference 98-HC-M-2
Collector
Phone (309) 793-5800
PWS Id & Type
Purchase Order 14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	< 1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	< 0.1 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	3.8 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	2.6 mg/kg as rec'd.	EPA 7421	SB/VD	04-01-1998
Total Nickel	< 5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	28 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory

The University of Iowa

Date of report: 04-07-1998

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MIKE COFFEY

US FISH & WILDLIFE SERVICE (1)

ROCK ISLAND FIELD OFFICE

4469-48TH AVENUE COURT

ROCK ISLAND IL 61201

Sample Number	9852599
Date Received	03-03-1998
Project	
Date Collected	01-28-1998
Collection Site	upper bend meander
Collection Town	Joachim Creek
Description	whole mouse
Reference	98-HC-M-3
Collector	
Phone	(309)-793-5800
PWS Id & Type	
Purchase Order	14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Arsenic	< 1 mg/kg as rec'd.	EPA 7060	SB/VD	04-02-1998
Total Cadmium	0.2 mg/kg as rec'd.	EPA 7131	SB/VD	04-01-1998
Total Copper	2.6 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Lead	3.0 mg/kg as rec'd.	EPA 7421	SB/VD	04-01-1998
Total Nickel	< 5.0 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998
Total Zinc	31 mg/kg as rec'd.	EPA 6010A	DC/VD	04-01-1998

Description of units used within this report

mg/kg as rec'd. - Milligrams per Kilogram as Received

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory



The University of Iowa

Date of report: 03-06-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9851120 Revision 1
Date Received 02-05-1998
Project
Date Collected 01-27-1998
Collection Site joachim creek outfall
Collection Town
Description water
Reference 001
Collector COFFEY MIKE
Phone (309) 793-5800
PWS Id & Type
Purchase Order 1448003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Hardness	380 mg/L as CaCO ₃	SM 2340 B	DC/VD	03-04-1998
Total Antimony	<0.005 mg/L	SM 3113B	ML/VD	02-16-1998
Total Arsenic	<0.01 mg/L	SM 3113B	ML/VD	02-12-1998
Total Cadmium	0.001 mg/L	SM 3113B	ML/VD	02-13-1998
Total Chromium	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Copper	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Lead	0.03 mg/L	SM 3113B	ML/VD	02-13-1998
Total Nickel	<0.05 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Silver	<0.01 mg/L	SM 3113B	ML/VD	02-12-1998
Total Zinc	0.08 mg/L	EPA 200.7	DC/VD	02-13-1998

Description of units used within this report

mg/L - Milligrams per Liter

mg/L as CaCO₃ - Milligrams per Liter as Calcium Carbonate

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.

MAR 9 1998

Mary J. R. Gächrist, Ph.D.
Director

102 Oakdale Campus, #101 OH
Iowa City, Iowa 52242-5002
319/335-4500 Fax: 319/335-4555

<http://www.uhl.uiowa.edu>

H.A. Wallace Building
East Grand, Des Moines, Iowa 50319-00
515/281-5371 Fax: 515/243-1349



Hygienic Laboratory

The University of Iowa

Date of report: 03-06-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (I)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9851122 Revision 1
Date Received 02-05-1998
Project
Date Collected 01-27-1998
Collection Site joachim creek outfall
Collection Town
Description water
Reference 001-B
Collector COFFEY MIKE
Phone (309) 793-5800
PWS-Id & Type
Purchase Order 1448003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/Verifier	Date Analyzed
Total Hardness	360 mg/L as CaCO ₃	SM 2340 B	DC/VD	03-04-1998
Total Antimony	<0.005 mg/L	SM 3113B	ML/VD	02-16-1998
Total Arsenic	<0.01 mg/L	SM 3113B	ML/VD	02-18-1998
Total Cadmium	0.002 mg/L	SM 3113B	ML/VD	02-13-1998
Total Chromium	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Copper	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Lead	0.09 mg/L	SM 3113B	ML/VD	02-13-1998
Total Nickel	<0.05 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Silver	<0.01 mg/L	SM 3113B	ML/VD	02-12-1998
Total Zinc	0.08 mg/L	EPA 200.7	DC/VD	02-13-1998

Description of units used within this report

mg/L - Milligrams per Liter

mg/L as CaCO₃ - Milligrams per Liter as Calcium Carbonate

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory

The University of Iowa

Date of report: 03-06-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9851123 Revision 1
Date Received 02-05-1998
Project
Date Collected 01-27-1998
Collection Site joachim creek ditch
Collection Town
Description water
Reference 002
Collector COFFEY MIKE
Phone (309) 793-5800
PWS Id & Type
Purchase Order 1448003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Hardness	920 mg/L as CaCO ₃	SM 2340 B	DC/VD	03-04-1998
Total Antimony	<0.005 mg/L	SM 3113B	ML/VD	02-16-1998
Total Arsenic	<0.01 mg/L	SM 3113B	ML/VD	02-18-1998
Total Cadmium	0.038 mg/L	SM 3113B	ML/VD	02-13-1998
Total Chromium	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Copper	<0.01 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Lead	0.04 mg/L	SM 3113B	ML/VD	02-13-1998
Total Nickel	0.12 mg/L	EPA 200.7	DC/VD	02-13-1998
Total Silver	<0.01 mg/L	SM 3113B	ML/VD	02-12-1998
Total Zinc	0.60 mg/L	EPA 200.7	DC/VD	02-13-1998

Description of units used within this report

mg/L - Milligrams per Liter

mg/L as CaCO₃ - Milligrams per Liter as Calcium Carbonate

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory



The University of Iowa

Date of report: 05-07-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9852174
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site flood plain
Collection Town Joachim Creek
Description mine tailings
Reference 98-HC-S-3
Collector
Phone (309) 793-5800
PWS Id & Type
Purchase Order I4480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Vegeter	Date Analyzed
Total Arsenic	28 mg/kg by dry wt	EPA 7060	ML/VD	03-20-1998
Total Cadmium	32 mg/kg by dry wt	EPA 6010A	DC/VD	03-20-1998
Total Copper	3200 mg/kg by dry wt	EPA 6010A	DC/VD	03-20-1998
Total Lead	23000 mg/kg by dry wt	EPA 6010A	DC/VD	03-20-1998
Total Nickel	140 mg/kg by dry wt	EPA 6010A	DC/VD	03-20-1998
Total Zinc	96000 mg/kg by dry wt	EPA 6010A	DC/VD	03-20-1998

Description of units used within this report

mg/kg by dry wt - Milligrams per Kilogram by Dry Weight

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.

THE UNIVERSITY OF IOWA



May 18, 1998

Mike Coffey
United States Fish & Wildlife Service
4469 48th Ave. Court
Rock Island, IL 61201

RE: UHL Sample Number 9852174

Dear Mr. Coffey:

Analytical and toxicity test results for the mine tailings sample listed above are enclosed. This sample was received by our Laboratory for effluent toxicity testing and metals analysis on March 3, 1998. As you requested, the unused portion of the mine talings sample is being returned (via UPS) under separate cover.

The University Hygienic Laboratory appreciates this opportunity to provide you with our services. Questions regarding the test or results should be directed to Mary Freitag or me.

The charge for these tests is \$450.00. The above charge will be deducted from your account (UHL account no. 53100) per our standing agreement. Please feel free to contact me at 515-281-5371, if you have any questions or comments.

Sincerely,

John G. Miller III
Limnologist

JM/jm

Enclosure
c: Accounting

HYGIENIC LABORATORY

Henry A. Wallace Building
Des Moines, Iowa 50319

Iowa's Environmental and
Public Health Laboratory

Telephone: 515/281-5371
Telefax: 515/243-1349
<http://www.uhl.uiowa.edu>

MAY 20

U.S. Fish & Wildlife Mine Tailings Study

A sample of mine tailings was received from Mr. Mike Coffey of the U.S. Fish & Wildlife Service on March 3, 1998. Upon receipt, a metals analysis was performed on the mine tailings. Results of the analysis were: Total Arsenic - 28 mg/kg, Total Cadmium - 32 mg/kg, Total Copper - 3,200 mg/kg, Total Lead - 23,000 mg/kg, Total Nickel - 140 mg/kg and Total Zinc - 96,000 mg/kg.

A modified range-finding test was performed beginning on March 25, 1998. This range-finding test used 100 g of mine tailings and 200 ml of synthetic mod hard water. This mixture was hand stirred for approximately 15 minutes. Ten fathead minnows were introduced after recording the pH, DO and temperature. The initial DO was 8.4 mg/L, pH was 7.5 units and the temperature was 20°C. The 24 hour mortality was 80%. The DO was 7.3 mg/L, pH was 7.6 units and temperature was 24°C at 24 hours.

A second range-finding test was performed on March 27, 1998 using 50g of mine tailings and 200 ml of synthetic mod hard water. The sample was hand stirred for 15 minutes followed by the recording of initial DO, pH and temperature. The initial DO was 7.6 mg/L, pH was 6.7 mg/L and temperature was 24°C. Ten fathead minnows were introduced to the sample. At 24 hours all ten fatheads were dead (100%) mortality. The 24 hour DO was 7.3 mg/L, pH was 7.0 mg/L and the temperature was 23 °C.

From these preliminary tests, the concentrations of a serial dilution were determined. A serial dilution consisting of 6 concentrations and a control were set up using synthetic mod hard water. Each concentration was prepared using four replicates. The concentrations used were: 100g, 50g, 25g, 12.5g, 6.25g, 3.125g and a control of synthetic mod hard water. The samples were prepared by taring each test beaker and bringing each up to a final calculated weight with mine tailings. Two hundred ml of mod hard water was added to each test beaker. Each replicate was stirred 15-20 times and placed on a shaker table for one hour. After shaking the samples were then allowed to settle for 1.5 hours. Initial DO, temperature and conductivity were performed and 5 eight-day old fathead minnows per replicate were introduced. The beakers were placed in the environmental chamber under "standard" toxicity test conditions ($25 \pm 1^\circ\text{C}$; 16 hours light and 8 hours darkness @ 2,000 ft candles). Mortality, pH, temperature and DO were recorded at each 24 hour interval. Each test beaker of fish was fed, beginning at 24 hours, with approximately 3 drops of concentrated brine shrimp. Left over food (uneaten brine shrimp) was removed from the test beakers daily.

In the 100% concentration (100g/200 ml), the initial DO and pH were 7.6 and 7.7 mg/L, respectively and the DO and pH in the same concentration at 96 hours was 8.5 and 7.7 mg/L, respectively. Initial conductivity (in the 100%) was 350 μmho and conductivity at 96 hours was 610 μmho . Dissolved oxygen fluctuated only slightly throughout the test. The pH remained very stable throughout the test.

Upon test completion, the 100g/200 ml elutriate was filtered and acid preserved for metals analysis. The results of this analysis were: Dissolved Cadmium, 0.11 mg/L, Dissolved Chromium, <0.02 mg/L, Dissolved Copper 0.16 mg/L, Dissolved Lead, 0.72 mg/L, Dissolved Nickel, 0.15 mg/L and Dissolved Zinc, 4.4 mg/L.

LC₅₀'s (concentration at which 50 percent of the organisms die) were calculable for all of the 24 hour test intervals. IC₂₅'s (concentration that causes inhibition of 25 percent of the organisms) were calculable for the 48, 72 and 96 hour mortality data. The results are tabulated below:

Time Interval	LC ₅₀	IC ₂₅	DO	pH
Initial	NA*	NA*	7.6 mg/L	7.7 units
24 hour LC ₅₀	100 gm/L	NC**	8.1 mg/L	7.8 units
48-hour LC ₅₀	44.3 gm/L	42.9 gm/L	7.6 mg/L	7.8 units
72 hour LC ₅₀	34.7 gm/L	40.6 gm/L	7.1 mg/L	7.7 units
96 hour LC ₅₀	29.3 gm/L	12.5 gm/L	8.5 mg/L	7.7 units

*NA = not applicable

**NC = not calculable

Attached you will find the statistical calculations for LC₅₀'s and IC₂₅'s at each 24 hour test interval.



University of Iowa Hygienic Laboratory Effluent Toxicity Testing Report Form

96-Hour Acute Nonrenewal Test

Client Name United States Fish & Wildlife Service Lab Sample # 9852174
 Project Mine Tailings Study Date Collected 1-28-1998
 Sampling Location Flood Plain/Jochim Creek
 Diluted effluent sample ratio (from permit) Serial Dilution
 Address 4469-48th Avenue Court Date Received 3-3-1998
 City/State/Zip Rock Island, Illinois 61201

MORTALITY DATA

Laboratory (Name) University Hygienic Laboratory
 Beginning Date 4-16-98 @ 1215 Ending Date 4-20-98 @ 1215

Pimephales promelas Mortality @ 24 Hours (Number Dead/Number Tested)

Conc.	Bk. 1	Bk. 2	Bk. 3	Bk. 4	Total
Ctrl.	0/5	0/5	0/5	0/5	0/20
100%	1/5	4/5	3/5	2/5	10/20
50%	0/5	2/5	2/5	1/5	5/20
25%	0/5	0/5	1/5	0/5	1/20
12.5%	0/5	1/5	0/5	1/5	2/20
6.25%	0/5	0/5	1/5	2/5	3/20
3.125%	0/5	0/5	0/5	0/5	0/20

LC₅₀ = 100 gm/L

IC₁₅ = Not Calculable

Pimephales promelas Mortality @ 48 Hours (Number Dead/Number Tested)

Conc.	Bk. 1	Bk. 2	Bk. 3	Bk. 4	Total
Ctrl.	0/5	0/5	0/5	0/5	0/20
100%	3/5	5/5	3/5	3/5	14/20
50%	2/5	3/5	4/5	3/5	12/20
25%	1/5	1/5	1/5	2/5	5/20
12.5%	0/5	1/5	1/5	2/5	4/20
6.25%	0/5	0/5	1/5	2/5	3/20
3.125%	0/5	0/5	0/5	0/5	0/20

LC₅₀ = 44.3 gm/L

IC₁₅ = 42.9 gm/L

Pimephales promelas Mortality @ 72 Hours (Number Dead/Number Tested)

Conc.	Bk. 1	Bk. 2	Bk. 3	Bk. 4	Total
Ctrl.	0/5	0/5	0/5	0/5	0/20
100%	4/5	5/5	5/5	3/5	17/20
50%	2/5	3/5	4/5	4/5	13/20
25%	1/5	1/5	1/5	2/5	5/20
12.5%	0/5	1/5	1/5	2/5	4/20
6.25%	0/5	0/5	1/5	2/5	3/20
3.125%	0/5	0/5	0/5	0/5	0/20

LC₅₀ = 34.7 gm/L

IC₁₅ = 40.6 gm/L

Pimephales promelas Mortality @ 96 Hours (Number Dead/Number Tested)

Conc.	Bk. 1	Bk. 2	Bk. 3	Bk. 4	Total
Ctrl.	0/5	0/5	0/5	0/5	0/20
100%	4/5	5/5	5/5	4/5	18/20
50%	2/5	4/5	4/5	4/5	14/20
25%	1/5	2/5	2/5	2/5	7/20
12.5%	0/5	1/5	1/5	3/5	4/20
6.25%	0/5	0/5	1/5	2/5	3/20
3.125%	0/5	0/5	0/5	0/5	0/20

LC₅₀ = 29.3 gm/L

IC₁₅ = 12.5 gm/L

ORGANISM DATA

<u>Pimephales promelas age</u>	<u>8 Days</u>
<u>Reference Toxicant</u>	<u>Sodium Chloride</u>
<u>Reference 48 Hour LC₅₀</u>	<u>6.46 gm/L</u>

SAMPLE DATA (100% EFFLUENT)

Time Interval in Hours	Temperature °C	Dissolved Oxygen (mg/L)	pH (units)
Initial	24	7.6	7.7
24	24	8.1	7.8
48	24	7.6	7.8
72	24	7.1	7.7
96	24	8.5	7.7

Date Reported: MAY 19 1983



Hygienic Laboratory

The University of Iowa

Date of report: 05-18-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9855084
Date Received 03-03-1998
Project
Date Collected 01-28-1998
Collection Site flood plain
Collection Town Joachim Creek
Description 96 hr elutriate tailing
Reference 98-HC-S-3
Collector
Phone (309) 793-5800
FWS Id & Type
Purchase Order 14480003941096

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Dissolved Cadmium	0.11 mg/L	EPA 200.7	DC/SGB	04-23-1998
Dissolved Chromium	<0.02 mg/L	EPA 200.7	DC/SGB	04-23-1998
Dissolved Copper	0.16 mg/L	EPA 200.7	DC/SGB	04-23-1998
Dissolved Lead	0.72 mg/L	EPA 200.7	DC/SGB	04-23-1998
Dissolved Nickel	0.15 mg/L	EPA 200.7	DC/SGB	04-23-1998
Dissolved Zinc	4.4 mg/L	EPA 200.7	DC/SGB	04-23-1998

Description of units used within this report

mg/L - Milligrams per Liter

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Martine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory



The University of Iowa

Date of report: 01-07-1998

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MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9764234
Date Received 12-19-1997
Project
Date Collected 11-21-1997 12:30
Collection Site baseball field 3-6"
Collection Town Herculaneum, Mo
Description soil
Reference HC-97-02B
Collector COFFEY MIKE
Phone (309) 793-5800

PWS Id & Type
Purchase Order

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Lead	140 mg/kg by dry wt	EPA 6010	DC/SGB	12-29-1997

Description of units used within this report

mg/kg by dry wt - Milligrams per Kilogram by Dry Weight

Iowa Laboratory Certification No. 027. DAIHA, ICR, NVLAP, USEPA and other credentials available upon request.

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Hygienic Laboratory

The University of Iowa

Date of report: 01-07-1998

|||||
MIKE COFFEY

US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9764235
Date Received 12-19-1997
Project
Date Collected 11-21-1997 12:30
Collection Site baseball field
Collection Town Herculaneum, Mo
Description soil
Reference HC-97-02A
Collector COFFEY MIKE
Phone (309) 793-5800
PWS Id & Type
Purchase Order

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Lead	260 mg/kg by dry wt	EPA 6010	DC/SGB	12-29-1997

Description of units used within this report

mg/kg by dry wt - Milligrams per Kilogram by Dry Weight

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory

The University of Iowa

Date of report: 01-07-1998

|||||
MIKE COFFEY
US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number	9764236
Date Received	12-19-1997
Project	
Date Collected	11-21-1997 12:00
Collection Site	boat ramp park 3-6"
Collection Town	Herculaneum, Mo
Description	soil
Reference	HC-97-01B
Collector	COFFEY MIKE
Phone	(309) 793-5800
PWS-Id & Type	
Purchase Order	

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Lead	140 mg/kg by dry wt	EPA 6010	DC/SGB	12-29-1997

Description of units used within this report

mg/kg by dry wt - Milligrams per Kilogram by Dry Weight

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.



Hygienic Laboratory

The University of Iowa

Date of report: 01-07-1998

|||||
MIKE COFFEY

US FISH & WILDLIFE SERVICE (1)
ROCK ISLAND FIELD OFFICE
4469-48TH AVENUE COURT
ROCK ISLAND IL 61201

Sample Number 9764237
Date Received 12-19-1997
Project
Date Collected 11-21-1997 12:00
Collection Site boat ramp park 0-3*
Collection Town Herculaneum, Mo
Description soil
Reference HC-97-01A
Collector COFFEY MIKE
Phone (309) 793-5800
PWS Id & Type
Purchase Order

Results of Analyses

Inorganic Chemistry

Analyte	Concentration	Method	Analyst/ Verifier	Date Analyzed
Total Lead	1000 mg/kg by dry wt	EPA 6010	DC/SGB	12-29-1997

Description of units used within this report

mg/kg by dry wt - Milligrams per Kilogram by Dry Weight

Iowa Laboratory Certification No. 027. AIHA, ICR, NVLAP, USEPA and other credentials available upon request.

If you have any questions please call Sherri Marine at 800/421-IOWA (4692) or 319/335-4500. Thank you.

(K)

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF CRIMINAL ENFORCEMENT, FORENSICS, AND TRAINING
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
REGION 7 TECHNICAL COORDINATOR
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103

November 27, 1998

MEMORANDUM

SUBJECT: Doe Run Lead Company Environmental Data - NEIC Project #RP-0519

FROM: Fred Niermann
Region 7 Technical Coordinator
National Enforcement Investigations Center

TO: Steven Howell, Special Agent in Charge
St. Louis Area Office

The undersigned an employee of EPA's National Enforcement Investigations Center (NEIC) sampled the waters and sediment adjacent to the Doe Run smelter tailings pile that is located next to Joachim Creek in Herculaneum, Jefferson County, MO. The waste pile was sampled on March 24, 1998 with the guidance of Fish and Wildlife Service SA Dan Burleson. The tailings pile was being flooded with Mississippi River water that was backing up the channel of Joachim Creek during an early spring flood event. The sample locations are shown on the attached map. The results of the analysis from the EPA - Region 7 laboratory is also attached. The data indicated that metals are present in the water being discharged from the culvert that is located at Doe Run 5 (sample results - Water 001). The water contained high concentrations of lead (133 mg/l), zinc (310 mg/l), and copper (11.8 mg/l). This discharge is directly into flood waters from the Mississippi River, a water of the United States.

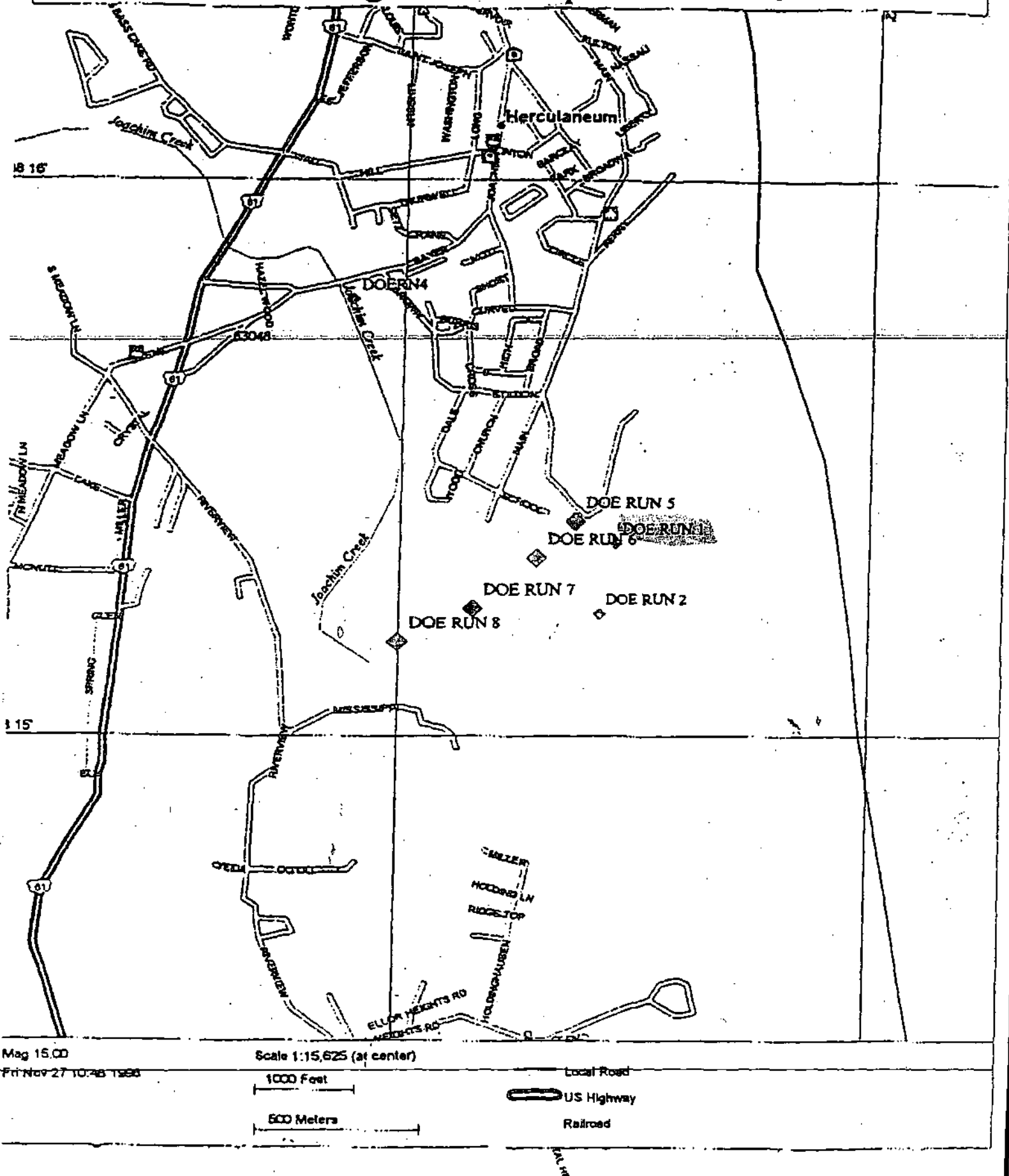
POINT
DISCHARGE

The other sites Doe Run 6-8 are located along the edge of the smelter tailings piles and show that metals are present in the water (sample results 002 - 004) and the smelter waste tailings (sediment samples 102 - 104).

Frederick J. Niermann

Frederick J. Niermann
Regional Technical Coordination - Region 7
National Enforcement Investigation Center

Doe Run Tailings Pile - Sample Locations 3/24/98



ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: 8-VGP30

VALIDATED DATA

COMPOUND	UNITS	WATER		WATER		WATER		WATER		SEDIMENT	
		001 (MAP-DUERUN 5)	002 (MAP-DUERUN 5)	002 (MAP-DUERUN 6)	003 (MAP-DUERUN 7)	003 (MAP-DUERUN 7)	004 (MAP-DUERUN 8)	004 (MAP-DUERUN 8)	102 (MAP-DUERUN 6)	102 (MAP-DUERUN 6)	102 (MAP-DUERUN 6)
VH03 ARSENIC, TOTAL, BY ICAP	UG/L	7.14	U	7.14	U	7.14	U	7.14	U		
VH04 BARIUM, TOTAL, BY ICAP	UG/L	118		93.0		110		65.7			
VH05 BERYLLIUM, TOTAL, BY ICAP	UG/L	0.27		0.420	U	0.420	U	0.420	U		
VH06 CADMIUM, TOTAL, BY ICAP	UG/L	4270		17.2		15.0		16.9			
VH07 COBALT, TOTAL, BY ICAP	UG/L	11300		21.2		52.2		13.6			
VH08 CHROMIUM, TOTAL, BY ICAP	UG/L	28.3		4.71		3.69	U	8.35			
VH09 COPPER, TOTAL, BY ICAP	UG/L	11800		272		117		101			
VH10 IRON, TOTAL, BY ICAP	UG/L	564000		2900		6430		1310			
VH11 MANGANESE, TOTAL, BY ICAP	UG/L	8240		114		114		42.7			
VH12 MOLYBDENUM, TOTAL, BY ICAP	UG/L	19.9		4.41	U	4.41	U	4.41	U		
VH13 NICKEL, TOTAL, BY ICAP	UG/L	8730		376		24.0		9.79			
VH14 LEAD, TOTAL, BY ICAP	UG/L	13300		6090		2090		760			
VH15 ANTIMONY, TOTAL, BY ICAP	UG/L	22.7		17.2	U	17.2	U	17.2	U		
VH16 SELENIUM, TOTAL, BY ICAP	UG/L	243		40.3	U	40.3	U	40.3	U		
VH17 TITANIUM, TOTAL, BY ICAP	UG/L	1180		50.7		79.8		37.8			
VH18 THALLIUM, TOTAL, BY ICAP	UG/L	36.5	U	36.5	U	55.2		36.5	U		
VH19 VANADIUM, TOTAL, BY ICAP	UG/L	2.51	U	2.51	U	2.51	U	2.51	U		
VH20 ZINC, TOTAL, BY ICAP	UG/L	310000		912		2340		441			
VH21 CALCIUM, TOTAL, BY ICAP	MG/L	504		20.7		22.8		19.3			
VH22 MAGNESIUM, TOTAL, BY ICAP	MG/L	120		9.66		10.7		9.53			
VH23 SODIUM, TOTAL, BY ICAP	MG/L	245		5.38		5.70		5.08			
VH24 POTASSIUM, TOTAL, BY ICAP	MG/L	114		2.83		2.93		2.98			
ZZ01 SAMPLE NUMBER	NA	001		002		003		004		102	
ZZ02 ACTIVITY CODE	NA	VGP30		VGP30		VGP30		VGP30		VGP30	

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ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: 8-VGP30

VALIDATED DATA
SEDIMENT

COMPOUND	UNITS	WATER				102 (MAP-DOERUNG)
		001 (MAP-DOERUNG)	002 (MAP-DOERUNG)	003 (MAP-DOERUNG)	004 (MAP-DOERUNG)	
SG07 SOLIDS, PERCENT	%					84.2
SH01 SILVER, TOTAL, BY ICAP	MG/KG					0.932
SH02 ALUMINUM, TOTAL, BY ICAP	MG/KG					19500
SH03 ARSENIC, TOTAL, BY ICAP	MG/KG					30.7
SH04 BARIUM, TOTAL, BY ICAP	MG/KG					629
SH05 BERYLLIUM, TOTAL, BY ICAP	MG/KG					3.81
SH06 CADMIUM, TOTAL, BY ICAP	MG/KG					115
SH07 COBALT, TOTAL, BY ICAP	MG/KG					3470
SH08 CHROMIUM, TOTAL, BY ICAP	MG/KG					29.4
SH09 COPPER, TOTAL, BY ICAP	MG/KG					1700
SH10 IRON, TOTAL, BY ICAP	MG/KG					189000
SH11 MANGANESE, TOTAL, BY ICAP	MG/KG					852
SH12 MOLYBDENUM, TOTAL, BY ICAP	MG/KG					70.2
SH13 NICKEL, TOTAL, BY ICAP	MG/KG					197
SH14 LEAD, TOTAL, BY ICAP	MG/KG					26900
SH15 ANTIMONY, TOTAL, BY ICAP	MG/KG					3.45 U
SH16 SELENIUM, TOTAL, BY ICAP	MG/KG					89.7
SH18 THALLIUM, TOTAL, BY ICAP	MG/KG					21.1 U
SH19 VANADIUM, TOTAL, BY ICAP	MG/KG					49.3
SH20 ZINC, TOTAL, BY ICAP	MG/KG					99900
SH21 CALCIUM, TOTAL, BY ICAP	MG/KG					77900
SH22 MAGNESIUM, TOTAL, BY ICAP	MG/KG					25500
SH23 SODIUM, TOTAL, BY ICAP	MG/KG					8720
SH24 POTASSIUM, TOTAL, BY ICAP	MG/KG					8100
WM01 SILVER, TOTAL, BY ICAP	UG/L	7.24	U 7.24	U 7.24	U 7.24	U
WM02 ALUMINUM, TOTAL, BY ICAP	UG/L	39200	2090	1990	1360	

JAN 06 '99

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Page 4

ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: B-VGP30

VALIDATED DATA

SEDIMENT

SEDIMENT

COMPOUND	UNITS	103	104
		(MAD-DREAW 7)	(MAD-DREAW 5)
SG07 SOLIDS, PERCENT	%	82.1	83.4
SH01 SILVER, TOTAL, BY ICAP	MG/KG	3.52	3.80
SH02 ALUMINUM, TOTAL, BY ICAP	MG/KG	20100	18600
SH03 ARSENIC, TOTAL, BY ICAP	MG/KG	5.17	11.2
SH04 BARIUM, TOTAL, BY ICAP	MG/KG	237	198
SH05 BERYLLIUM, TOTAL, BY ICAP	MG/KG	3.22	3.24
SH06 CADMIUM, TOTAL, BY ICAP	MG/KG	70.4	77.7
SH07 COBALT, TOTAL, BY ICAP	MG/KG	2290	2350
SH08 CHROMIUM, TOTAL, BY ICAP	MG/KG	73.3	68.7
SH09 COPPER, TOTAL, BY ICAP	MG/KG	2520	3180
SH10 IRON, TOTAL, BY ICAP	MG/KG	196000	190000
SH11 MANGANESE, TOTAL, BY ICAP	MG/KG	1130	962
SH12 MOLYBDENUM, TOTAL, BY ICAP	MG/KG	79.8	67.7
SH13 NICKEL, TOTAL, BY ICAP	MG/KG	148	163
SH14 LEAD, TOTAL, BY ICAP	MG/KG	16200	22700
SH15 ANTIMONY, TOTAL, BY ICAP	MG/KG	16.5	13.4
SH16 SELENIUM, TOTAL, BY ICAP	MG/KG	84.7	88.3
SH18 THALLIUM, TOTAL, BY ICAP	MG/KG	21.1	21.1
SH19 VANADIUM, TOTAL, BY ICAP	MG/KG	1.87	29.2
SH20 ZINC, TOTAL, BY ICAP	MG/KG	83300	85400
SH21 CALCIUM, TOTAL, BY ICAP	MG/KG	84900	70200
SH22 MAGNESIUM, TOTAL, BY ICAP	MG/KG	25300	31700
SH23 SODIUM, TOTAL, BY ICAP	MG/KG	7870	6050
SH24 POTASSIUM, TOTAL, BY ICAP	MG/KG	8660	7360
ZZ01 SAMPLE NUMBER	NA	103	104
ZZ02 ACTIVITY CODE	NA	VGP30	VGP30

JAN 06 '99

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ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF CRIMINAL ENFORCEMENT, FORENSICS, AND TRAINING
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
REGION 7 TECHNICAL COORDINATOR
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103

November 27, 1998

MEMORANDUM

SUBJECT: Doe Run Lead Company Environmental Data - NEIC Project #RP-0519

FROM: Fred Niermann
Region 7 Technical Coordinator
National Enforcement Investigations Center

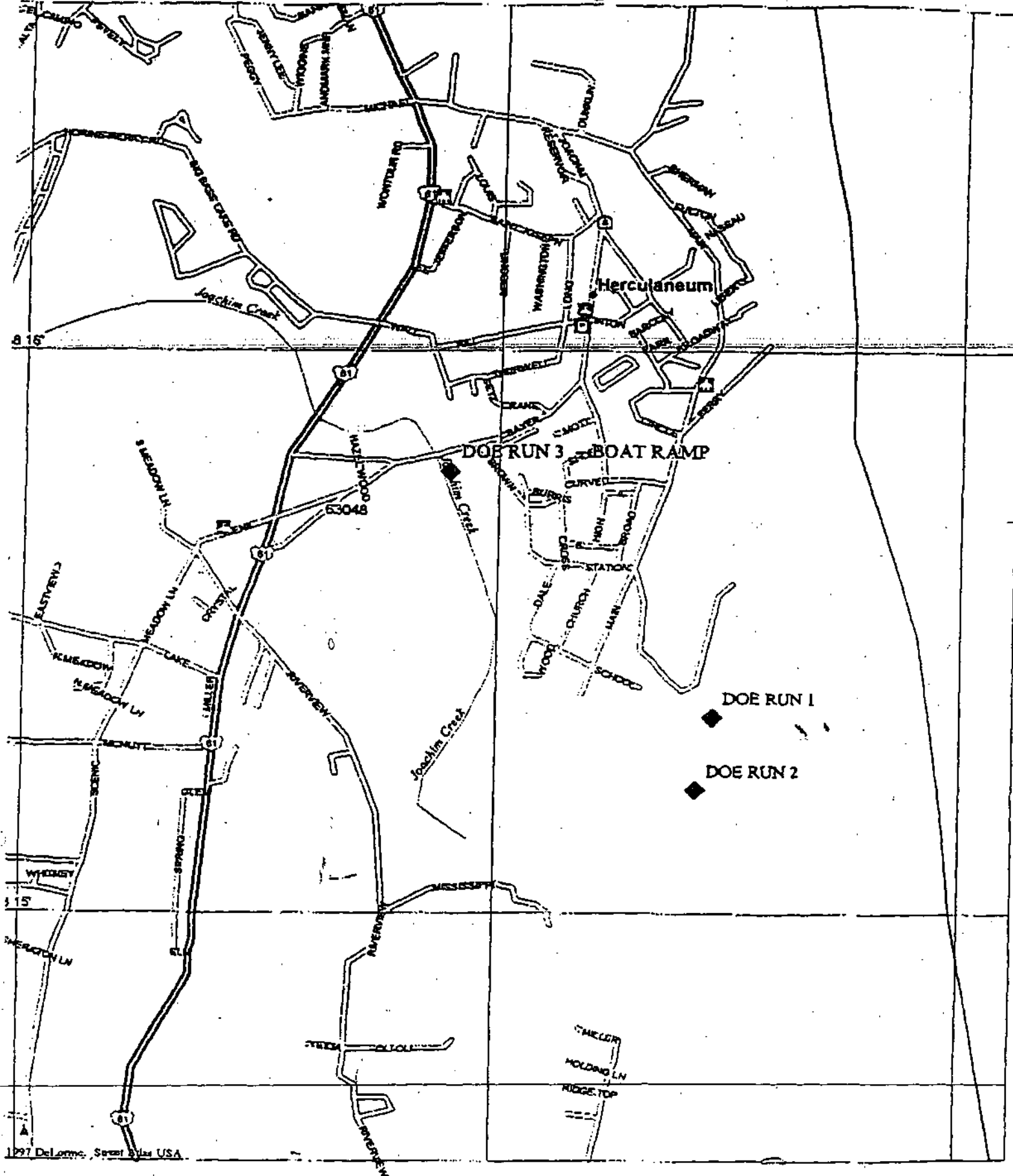
TO: Steven Howell, Special Agent in Charge
St. Louis Area Office

The undersigned an employee of EPA's National Enforcement Investigations Center (NEIC) sampled the waters and sediment of Joachim Creek adjacent to the Doe Run lead smelter in Herculaneum, Jefferson County, MO on February 9, 1998. The creek was sampled at two locations where storm water from the Doe Run facility enters Joachim Creek, a water of the United States. An upstream sample was also obtained from the boat ramp in the town of Herculaneum. The sample locations are shown on the attached map. The results of the analysis from the EPA - Region 7 laboratory is also attached. The data indicated that higher concentrations of total metals are present in the water and sediment at locations 101(water), 101(sediment), 102 (water), 002 (sediment) adjacent to the Doe Run waste pile than the upstream location of 103(water) and 003(sediment) located at the Herculaneum boat ramp..

Frederick J. Niermann

Frederick J. Niermann
Regional Technical Coordination - Region 7
National Enforcement Investigation Center

Doe Run / Joachim Creek Sample Locations 2/9/98



ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: 8-VFMO3

VALLOATED DATA

COMPOUND	UNITS	001	002	003	101	102
SG07 SOLIDS, PERCENT	X				55.1	66.0
SH01 SILVER, TOTAL, BY ICAP	MG/KG				0.512 U	0.512 U
SH02 ALUMINUM, TOTAL, BY ICAP	MG/KG				12100	11100
SH03 ARSENIC, TOTAL, BY ICAP	MG/KG				5.43	4.94
SH04 BARIUM, TOTAL, BY ICAP	MG/KG				244	195
SH05 BERYLLIUM, TOTAL, BY ICAP	MG/KG				0.670	0.681
SH06 CADMIUM, TOTAL, BY ICAP	MG/KG				11.4	9.90
SH07 COBALT, TOTAL, BY ICAP	MG/KG				18.2	14.4
SH08 CHROMIUM, TOTAL, BY ICAP	MG/KG				18.0	15.8
SH09 COPPER, TOTAL, BY ICAP	MG/KG				49.8	47.1
SH10 IRON, TOTAL, BY ICAP	MG/KG				16300	16600
SH11 MANGANESE, TOTAL, BY ICAP	MG/KG				1050	659
SH12 MOLYBDENUM, TOTAL, BY ICAP	MG/KG				0.211 U	0.908
SH13 NICKEL, TOTAL, BY ICAP	MG/KG				29.4	28.1
SH14 LEAD, TOTAL, BY ICAP	MG/KG				737	812
SH15 ANTIMONY, TOTAL, BY ICAP	MG/KG				1.28	0.989
SH16 SELENIUM, TOTAL, BY ICAP	MG/KG				7.39	7.03
SH18 THALLIUM, TOTAL, BY ICAP	MG/KG				2.11 U	2.11 U
SH19 VANADIUM, TOTAL, BY ICAP	MG/KG				24.3	22.2
SH20 ZINC, TOTAL, BY ICAP	MG/KG				335	251
SH21 CALCIUM, TOTAL, BY ICAP	MG/KG				12100	7630
SH22 MAGNESIUM, TOTAL, BY ICAP	MG/KG				6360	4640
SH23 SODIUM, TOTAL, BY ICAP	MG/KG				160	148
SH24 POTASSIUM, TOTAL, BY ICAP	MG/KG				1220	1000
UH01 SILVER, TOTAL, BY ICAP	UG/L	7.24 U	7.24 U	7.24 U		
UH02 ALUMINUM, TOTAL, BY ICAP	UG/L	681	168	199		

ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: B-WFN03

VALIDATED DATA

COMPOUND	UNITS	103				
SG07 SOLIDS, PERCENT	X	63.3				
SM01 SILVER, TOTAL, BY ICAP	MG/KG	0.512	U			
SM02 ALUMINUM, TOTAL, BY ICAP	MG/KG	9530				
SM03 ARSENIC, TOTAL, BY ICAP	MG/KG	3.38				
SM04 BARIUM, TOTAL, BY ICAP	MG/KG	172				
SM05 BERYLLIUM, TOTAL, BY ICAP	MG/KG	0.559				
SM06 CADMIUM, TOTAL, BY ICAP	MG/KG	11.0				
SM07 COBALT, TOTAL, BY ICAP	MG/KG	60.0				
SM08 CHROMIUM, TOTAL, BY ICAP	MG/KG	13.7				
SM09 COPPER, TOTAL, BY ICAP	MG/KG	21.2				
SM10 IRON, TOTAL, BY ICAP	MG/KG	14200				
SM11 MANGANESE, TOTAL, BY ICAP	MG/KG	638				
SM12 MOLYBDENUM, TOTAL, BY ICAP	MG/KG	0.211	U			
SM13 NICKEL, TOTAL, BY ICAP	MG/KG	56.6				
SM14 LEAD, TOTAL, BY ICAP	MG/KG	109				
SM15 ANTIMONY, TOTAL, BY ICAP	MG/KG	1.14				
SM16 SELENIUM, TOTAL, BY ICAP	MG/KG	6.35				
SM18 THALLIUM, TOTAL, BY ICAP	MG/KG	2.11	U			
SM19 VANADIUM, TOTAL, BY ICAP	MG/KG	18.5				
SM20 ZINC, TOTAL, BY ICAP	MG/KG	739				
SM21 CALCIUM, TOTAL, BY ICAP	MG/KG	7260				
SM22 MAGNESIUM, TOTAL, BY ICAP	MG/KG	4230				
SM23 SODIUM, TOTAL, BY ICAP	MG/KG	134				
SM24 POTASSIUM, TOTAL, BY ICAP	MG/KG	1200				
II01 SAMPLE NUMBER	NA	103				
II02 ACTIVITY CODE	NA	WFN03				

ANALYSIS REQUEST DETAIL REPORT

ACTIVITY: 8-WFN03

VALIDATED DATA

COMPOUND	UNITS	001	002	003	101	102
UH03 ARSENIC, TOTAL, BY ICAP	UG/L	7.14 U	7.14 U	8.22 U		
UH04 BARIUM, TOTAL, BY ICAP	UG/L	150	137	134		
UH05 BERYLLIUM, TOTAL, BY ICAP	UG/L	0.420 U	0.420 U	0.420 U	U	
UH06 CADMIUM, TOTAL, BY ICAP	UG/L	5.93	0.592 U	0.592 U	U	
UH07 COBALT, TOTAL, BY ICAP	UG/L	2.47 U	3.71	8.98		
UH08 CHROMIUM, TOTAL, BY ICAP	UG/L	3.69 U	3.69 U	3.69 U	U	
UH09 COPPER, TOTAL, BY ICAP	UG/L	24.3	3.97	4.13		
UH10 IRON, TOTAL, BY ICAP	UG/L	1540	1210	872		
UH11 MANGANESE, TOTAL, BY ICAP	UG/L	295	175	200		
UH12 MOLYBDENUM, TOTAL, BY ICAP	UG/L	4.41 U	4.41 U	4.41 U	U	
UH13 NICKEL, TOTAL, BY ICAP	UG/L	594	448	628		
UH14 LEAD, TOTAL, BY ICAP	UG/L	800	16.3	10.4	U	
UH15 ANTIMONY, TOTAL, BY ICAP	UG/L	17.2 U	17.2 U	17.2 U	U	
UH16 SELENIUM, TOTAL, BY ICAP	UG/L	40.3 U	40.3 U	40.3 U	U	
UH17 TITANIUM, TOTAL, BY ICAP	UG/L	18.7	4.18 U	5.32		
UH18 THALLIUM, TOTAL, BY ICAP	UG/L	36.5 U	64.1	36.5 U	U	
UH19 VANADIUM, TOTAL, BY ICAP	UG/L	2.51 U	2.51 U	2.51 U	U	
UH20 ZINC, TOTAL, BY ICAP	UG/L	112	14.5	77.8		
UH21 CALCIUM, TOTAL, BY ICAP	MG/L	58.6	55.3	57.4		
UH22 MAGNESIUM, TOTAL, BY ICAP	MG/L	36.4	35.6	34.8		
UH23 SODIUM, TOTAL, BY ICAP	MG/L	21.0	18.6	19.3		
UH24 POTASSIUM, TOTAL, BY ICAP	MG/L	2.53	2.10	2.75		
Z101 SAMPLE NUMBER	NA	001	002	003	101	102
Z102 ACTIVITY CODE	NA	WFN03	WFN03	WFN03	WFN03	WFN03

Appendix B

Photographic Record

Photographic Record

Index

Photograph Number: 1

Subject: Areal View of Slag Piles in Joachim Creek Floodplain. The Mississippi River is in background. Joachim Creek and the City of Herculaneum are in the foreground.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: Southeast

Photograph Number: 2

Subject: Close Up Ground Level View of Slag Piles in Joachim Creek Floodplain

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: Northwest

Photograph Number: Repeat of Number 1

Subject: Note flood conditions for Joachim Creek and sheetwater adjacent to slag piles.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: Southeast

Photograph Number: 3

Subject: Areal View of Slag Piles in Joachim Creek Floodplain. Joachim Creek at left edge of photograph and sheetwater pool at right edge of photograph.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: North

Photograph Number: 4

Subject: Closer View of Photograph Number 3. Note area just top of center that illustrates the potential for erosion and transportation of slag materials from the slag piles on into Joachim Creek.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: North

Photographic Record

Index (continued)

Photograph Number: 5

Subject: Joachim Creek Floodplain Ditch One Adjacent to Slag Piles. Note that the ditch is full of Joachim Creek floodwater and this photograph illustrates the potential for erosion and transportation of slag material from the slag piles on into Joachim Creek.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: North

Photograph Number: 6

Subject: Joachim Creek Floodplain Ditch Two Adjacent to Slag Piles. Note that the ditch is full of Joachim Creek floodwater and this photograph illustrates the potential for erosion and transport of slag material from the slag piles on into Joachim Creek.

Photographer: USFWS-LE, Dan Burleson

Date: March 1998

Direction: Northwest

Photograph Number: 7

Subject: Joachim Creek Pool of Surface Water and Outlet Ditch Three. Note that the ditch is full of Joachim Creek floodwater and this photograph illustrates the potential of erosion and transport of slag material from the slag piles on into Joachim Creek.

Photographer: USFWS-LE

Date: March 1998

Direction: Northwest
